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WADC TECHNICAL REPORT 54-83
Part 2

EXPERIMENTAL MAGNESIUM ALLOYS

Part 2 Wrought Alloy Survey of Minor Additions to Selected Mg-Base Alloys.

Edited by

H. A. Johnson, 1st Lt., USAF

Materials Laboratory

JUNE 1954

WRIGHT AIR DEVELOPMENT CENTER

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June 1954

Materials Laboratory Contract
No. AF(600)19147
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Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Paterson Air Force Base, Ohio

FOREWORD

This report was prepared by The Dow Chemical Company under USAF Contract No. AF(600)19147. The contract was initiated under Research and Development Order No. R615-15 BA, "New Experimental Alloys by the Powder Metallurgy Process", and was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with Lt H. A. Johnson acting as project engineer.

ABSTRACT

The effect of 1% additions of Ba, Cb, Cr, Hg, Li, MM, Mo, Pd, Se, Ta, Te, Th, Ti, Tl, V, and W on the mechanical properties, workability, formability, corrosion resistance, and microstructure of Mg-3Zn and Mg-5Al was investigated. Th greatly improves the strength of Mg-3Zn in both extrusions and rolled strip without an appreciable loss of toughness (NBE) as illustrated below:

	Extrusion-T5					Rolled Strip-H24			
		1000 psi					1000 psi		
Alloy	%E	TYS	CYS	TS	NBE	%E	TYS	CYS	TS
Mg-3Zn	17	22	12	35	25	13	24	18	33
Mg-3Zn-1Th	14	31	20	40	23	16	32	24	39

Smaller strength increases are obtained by the addition of Li, Ba, and Pd to both base alloys and with Hg and Cr in Mg-3Zn. Sizeable strength increases, through the addition of Th, Li, Pd, or Ba, are achieved only with an appreciable loss in workability, toughness, formability, and/or corrosion resistance. The other additions, Cb, MM, Mo, Se, Ta, Te, Ti, Tl, V, and W, have negligible effects.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

M. E. SORTE
Colonel, USAF
Chief, Materials Laboratory
Directorate of Research

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INTRODUCTION:

The purpose of this study was to investigate the effect of small additions of elements not adequately covered in previous work.

The elements selected for further study are MM, Hg, Tl, Pd, Li, Th, Cr, Cb, Mo, Se, Te, Ba, Ti, V, and W. Since Zn and Al are two of the most important strengthening elements when alloyed with magnesium, Mg-3Zn and Mg-5Al were selected as the base alloys. Single additions of 1% of the third element were considered sufficient. The beneficial additions discovered in this work were also studied in part one of this contract.

SUMMARY OF EXPERIMENTAL RESULTS

A) Alloying(Table 1)

1.) The solubility of Cb, Cr, Mo, Se, Ta, Ti, Te, V, and W in both base alloys and Th in Mg-5Al is very small.
2.) The other additions-Ba, Hg, Li, MM, Pd, Th(in Mg-3Zn) and Tl-are quite soluble.

B)Microstructure(Table 2)

1.) The cast grain size is apparently decreased by Hg, Pd, Li, Se, V, W, and Ta in Mg-3Zn and appreciably increased by all additions to Mg-5Al except Pd and Ta.
2.) Th and Ba appreciably decrease the grain size of Mg-3Zn extrusions.
3.) Compound rating is increased by Pd and Ba in both alloys, Th in Mg-3Zn, and MM and Li in Mg-5Al.

C) Workability (Table 3)

1.) Workability of all alloys is good.
2.) The hot rolling range is narrowed by the addition of Pd, Th, and Ba in Mg-3Zn and Li and Ba in Mg-5Al.

D) Mechanical Properties (Table 5)

1.) Strength (particularly CYS) is significantly increased by the addition of Th, Ba, Pd, Li, Hg, and Cr to Mg-3Zn and Ba, Li, and Pd to Mg-5Al(Table 5).
2.) The addition of Th to Mg-3Zn results in, by far, the greatest improvement in mechanical properties. Typical properties of extrusions and rolled strip are presented below:

Alloy	Extrusion-T5 %E	Extrusion-T5 1000 PSI TYS	CYS	TS	NBE	Rolled Strip-H24 %E	Rolled Strip-H24 1000 PSI TYS	CYS	TS
Mg-3Zn	17	22	12	35	25	13	24	18	33
Mg-3Zn-1Th	14	31	20	40	23	16	32	24	39

3.) The ageability of Mg-3Zn is decreased by Th, Pd, and Ba, and increased by Li. The Mg-5Al alloys have poor ageability.

E) Formability (Table 3)
The minimum bend radius is increased by Pd, Li, and Ba in both base alloys and by Th in Mg-3Zn.

F) Corrosion (Table 4)
1.) The corrosion rate of Mg-3Zn extrusions is increased by Ba, Th, and Pd (in order of increasing effect).
2.) All of the Mg-5Al base alloys (unsettled) have poor corrosion resistance.

CONCLUSIONS

The addition of Th offers a large improvement in the mechanical properties of Mg-3Zn sheet and extrusions. Smaller, but significant strength increases can be obtained in both base alloys by the addition of Ba, Pd, and Li. These improvements in mechanical properties are accompanied by appreciable loss of toughness, workability, formability and/or corrosion resistance.

EXPERIMENTAL WORK

Laboratory-size melts of the desired composition were made with cell Mg and cast into extrusion ingots. Melt samples were taken for chemical analyses, which appear in Table 1. Fracture slices, about 1/4" thick, were taken from the extrusion ingots, fractured, and evaluated for cleanliness according to the standard reproduced in Fig 1. Metallographic samples were also taken

from the slices to determine the cast microstructure of the alloys.

The extrusion ingots were scalped, cut to the desired length, preheated, loaded into the extrusion press, and forward extruded into strip under various conditions to evaluate the extrusion characteristics of the alloys. Strips for rolling were also prepared by extrusion and were cut to convenient lengths. The hot and cold rollability of the alloys were determined and used as a guide in rolling the extruded strips for property evaluation.

Samples were taken from the extruded and rolled strips and tested for tensile and compressive strength, toughness, formability, and corrosion resistance. Tension and compression tests were run in the conventional manner, while the 60°V notch bend test was used to determine the relative toughness of the alloys. Formability was determined by finding the minimum 90° bend that could be made with rolled strip in the soft temper. The relative corrosion resistance of the alloys was determined by alternate immersion of samples in 3%NaCl at 95F.

DISCUSSION

A) Alloying

The analyses (Table 1) of the alloys indicate that many of the additions--Cb, Mo, Se, Te, W, V, and Ta--are insoluble in magnesium. Ti is slightly soluble (0.01%) in Mg-3Zn, but negligibly soluble in Mg-5Al. Although Cr could not be detected chemically (0.0%), its presence was detected spectrographically in both alloys. The other additions--MM, Hg, Tl, Pd, Li, Th, and Ba were quite soluble in magnesium. The Al was inadvertently omitted from the Mg-5Al-1Th alloy (no. 71598), leaving a Mg-1Th binary. A second melt (alloy no. 72094) was later made. Nil Th was present in this alloy due to its incompatibility with Al.

B) Microstructure

The grain size, compound rating, and cleanliness of the alloys are given in Table 2. Several additions--Hg, Pd, Li, Si V, W, and Ta--apparently decrease the cast grain size of Mg-3Zn, but none of the additions refine the fine-grained Mg-5Al base. In fact all the additions except Pd and Ta increased the cast grain size of Mg-5Al. Much less variation in grain size is encountered in the extruded microstructure. Th and Ba appreciably decreased the grain size of Mg-3Zn extrusions. Several other additions resulted in smaller changes which may not be significant. A significant increase in compound rating was given by Pd and Ba in both base alloys, by Th in Mg-3Zn, and by MM and Li in Mg-5Al. A solution heat treatment, sufficient to substantially homogenize the base alloys, resulted in a small, if any, decrease in the compound rating of the above alloys. Photomicrographs of the microstructure of the alloys which are substantially different from the bases are given in Figs 2, 3(cast), 4, and 5(extruded). The quality of the ingots, rated for cleanliness, was generally good. The Li and Te alloys, however, contained considerable flux inclusions.

C) Workability

All of the alloys have excellent workability. They can be extruded at least 30 feet per minute, hot rolled over a range of 450F or more, and cold rolled in the soft temper a reduction of 50% before cracking. The width of hot rolling range is slightly reduced by Pd, Th, and Ba in Mg-3Zn and Li and Ba in Mg-5Al.

D) Mechanical Properties

The mechanical properties of the alloys extruded and rolled under a variety of conditions were determined. Analysis of the data indicated that the effects of the additions were quite consistent and varied only slightly with fabrication conditions. In order to minimize random variations due to error, the properties were averaged (Table 5), and the overall effects of the additions were calculated. However, typical

properties of the base alloys containing the beneficial additions are given for extrusions (Table 6) and rolled strip (Table 7).

The results clearly indicate that the addition of Th to Mg-3Zn results in the largest improvement in properties. Other additions which increase the CYS of Mg-3Zn by 1,000 psi or more are Ba, Pd, Li, Hg, and Cr(in order of decreasing effect). Only small improvements in the properties of Mg-5Al were obtained. Ba, Li, and Pd raise the CYS an average of 1,000 to 2,000 psi. The other additions have insignificant effects on the properties of the base alloys. These additions, Th, Ba, Li, Pd, Hg, and Cr, which yielded strength increases in either or both of the base alloys, were also studied in part one of this contract. The benefit of Th in both extrusions (Table 6) and rolled strip (Table 7) is illustrated below:

	Extrusion-T5					Rolled Strip-H24			
		1000 psi					1000 psi		
Alloy	%E	TYS	CYS	TS	NBE	%E	TYS	CYS	TS
Mg-3Zn	17	22	12	35	25	13	24	18	33
Mg-3Zn-1Th	14	31	20	40	23	16	32	24	39

It is notable that these improvements can be obtained without appreciable loss of toughness (NBE). Slightly larger strength increases are yielded by Th in the as-extruded and annealed conditions. The benefit of Li in Mg-3Zn extrusions is also notable because strength (particularly CYS) is increased with no loss in toughness. Additions of Ba or Pd give similar improvement but decrease toughness. Hg and Cr are not deleterious to toughness of Mg-3Zn extrusions but give only small strength increases. In Mg-3Zn sheet Ba, Pd, Li, Hg, and Cr are equivalent in the H24 temper but Ba and Pd have higher strength in the soft (O) temper. Ba, Li, and Pd give only minor strength increases and also lower the toughness of Mg-5Al sheet. The ageability of Mg-3Zn is increased by Li and decreased by Th, Pd, and Ba. Ageability of all the Mg-5Al alloys is poor.

E) Formability

The minimum bend radius of rolled strips in the soft temper is given in Table 3. Formability is decreased by Pd, Li, and Ba in both base alloys and by Th in Mg-3Zn. The other additions have little or no effect.

F) Corrosion

The corrosion rate of Mg-3Zn is increased from 0.4 mcd to 0.6 mcd by Ba, to 5.2 mcd by Th, and to 100-200 mcd by Pd. All of the Mg-5Al alloys had high corrosion rates, and it is difficult to determine the effect of the additions. The Mg-5Al alloys containing MM and Cr have the lowest corrosion rates. The high corrosion rates of the Mg-5Al alloys are probably due to the fact that the alloys were not settled to reduce the Fe content (average of 25 ppm). It is interesting to note that the Mg-3Zn base alloys were not affected by an equivalent iron content (average of 27 ppm).

Table I

CHEMICAL ANALYSES

A) Mg-3Zn Alloys

Alloy No.	% Zn	% Other
71561	3.03	1.16MM
71562	2.97	1.03 Hg
71563	2.95	1.15 Tl
71564	2.75	1.12 Pd
71565	3.01	0.87 Li
71566	2.97	1.05 Th
71567	2.96	------
71568	2.87	0.0 Cr (Presence*)
71569	3.02	Nil Cb*
71570	3.07	Nil Mo*
71571	2.94	Nil Se
71572	2.92	Nil Te*
71573	3.04	0.69 Ba
71574	3.03	0.01 Ti
71575	3.00	Nil V*
71576	2.99	Nil W*
71577	2.96	Nil Ta*
71655	2.95	0.0 Cr(Presence*)

* Spectrographic analysis; otherwise chemical

Table I (cont.)

B) Mg-5Al Alloys

Alloy No.	% Al	% Other
71587	4.95	-----
71588	4.62	1.20 MM
71589	4.86	1.27 Hg
71590	4.98	0.71 Li
71591	4.97	Nil Se
71592	5.00	Nil Te*
71593	4.84	0.92 Pd
71594	4.93	0.0 Cr (Presence*)
71595	4.90	Nil Cb*
71596	4.90	Nil Mo*
71597	4.91	1.49 Tl
71599	4.70	Nil Ti*
71600	5.00	Nil V*
71601	4.77	Nil W*
71602	4.72	Nil Ta*
71603	4.99	0.76 Ba
71598**	-----	1.14 Th
72094	4.82	Nil Th

* Spectrographic analyis; otherwise chemical

** Al inadvertently omitted

Table II

MICROSTRUCTURE

A) Mg-3Zn Alloys

Alloy Number	Addition	Cleanliness	Cast Cpd.Rating AC	Cast Cpd.Rating SHT	Grain SizeX10³in. AC	Grain SizeX10³in. ASX
71567	---	0	2.5	.5	30	0.8
71561	MM	0	2	.5	30	0.8
71562	Hg	0	2	0	12	0.8
71563	Tl	0	3	.5	20	1.0
71564	Pd	0	8	8	10	0.6
71565	Li	3	3	.5	15	0.6
71566	Th	0	6	4	40*	0.4
71569	Cb	0	2	.5	20	0.8
71570	Mo	0	3	1	40	0.6
71571	Se	1	2.5	.5	15	0.6
71572	Te	5	2	1	30	0.8
71573	Ba	1	6	6	20	0.4
71574	Ti	0	2.5	0	30	0.8
71575	V	0	1.5	.5	9	0.6
71576	W	1	2.5	1	10	0.8
71577	Ta	0	1.5	1	8	0.8
71655	Cr	0	2.5	1	50	0.6

* Partly columnar

Table II (cont.)

B) Mg-5Al Alloys

Alloy Number	Addition	Cleanliness	Cast Cpd. Rating AC	Cast Cpd. Rating SHT	Grain Size $\times 10^3$ in. AC	Grain Size $\times 10^3$ in. ASX
71587	---	1	2	1	2	0.6
71588	MM	0	6	6	Col.	0.4
71589	Hg	0	3	1	12	0.6
71590	Li	2	5	5	15	0.6
71591	Se	0	3.5	1	30	0.6
71592	Te	5	2.5	1	15	0.6
71593	Pd	0	5	5	4	0.4
71594	Cr	0	4	1	30*	0.4
71595	Cb	0	4	1	60*	0.6
71596	MO	1	3.5	1	40	0.6
71597	Tl	0	3.5	1.	25	0.6
71599	Ti	1	3	1	50*	0.6
71600	V	1	2.5	0.5	60	0.6
71601	W	0	2	1	35*	0.6
71602	Ta	0	4	1	2	0.8
71603	Ba	1	5	3	25	0.6
71598**	Th	0	3.5	3.5	Col.	0.4

* Partly columnar (col.)

** Al inadvertently omitted---Mg-1Th binary

Table III

WORKABILITY AND FORMABILITY

A) Mg-3Zn Alloys

Alloy No.	Addition	Extrudability(fpm)	Hot Rolling Range(°F)	Max.Cold* Rollability(%)	Min.Bend* Radius(t)
71567	---	>30	700	44	3.5
71561	MM	"	650	52	3
71562	Hg	"	650	52	3
71563	Tl	"	650	50	3.5
71564	Pd	"	450	48	5.5
71565	Li	"	700	52	4.5
71566	Th	"	550	54	5.5
71569	Cb	"	700	55	3.5
71570	Mo	"	700	50	3
71571	Se	"	700	52	3
71572	Te	"	700	50	3.5
71573	Ba	"	550	51	6
71574	Ti	"	700	51	3.5
71575	V	"	650	50	4
71576	W	"	650	50	3.5
71577	Ta	"	650	50	4
71655	Cr	"	700	52	4

* Rolled strip in soft temper

Table III (cont.)

B) Mg-5Al Alloys

Alloy No.	Addition	Extrudability (fpm)	Hot Rolling Range (F)	Max. Cold* Rollability (%)	Min. Bend* Radius (t)
71587	---	>30	600	50	4
71588	MM	"	600	50	4
71589	Hg	"	700	53	3
71590	Li	"	550	52	5
71591	Se	"	650	52	3.5
71592	Te	"	700	52	3.5
71593	Pd	"	650	52	5
71594	Cr	"	700	52	4
71595	Cb	"	700	58	3
71596	Mo	"	700	53	3.5
71597	Tl	"	700	52	3
71599	Ti	"	700	56	3
71600	V	"	650	55	3.5
71601	W	"	700	53	3
71602	Ta	"	700	53	3
71603	Ba	"	500	48	6
71598**	Th	"	150	>88	3.5

* Rolled strip in soft temper

** Al inadvertently omitted; Mg-1Th binary

Table IV

CORROSION RATE

A) Mg-3Zn Alloys

Alloy No.	Addition	Corrosion Rate(mcd*)
71567	--	0.42
71561	MM	0.43
71562	Hg	0.40
71563	Tl	0.31
71564	Pd	100-200
71565	Li	0.40
71566	Th	5.19
71569	Cb	0.43
71570	Mo	0.45
71571	Se	0.44
71572	Te	0.41
71573	Ba	0.62
71574	Ti	0.41
71575	V	0.43
71576	W	0.40
71577	Ta	0.53
71655	Cr	0.47

* Milligrams per square centimeter per day

Table IV (cont.)

B) Mg-5Al Alloys

Alloy No.	Addition	Corrosion Rate(mcd*)
71587	--	100-200
71588	MM	30-50
71589	Hg	70-100
71590	Li	70-100
71591	Se	59.9
71593	Pd	100-200
71594	Cr	30-50
71595	Cb	100
71596	Mo	70-100
71597	Tl	100-200
71599	Ti	55.9
71600	V	61.6
71601	W	100-200
71602	Ta	70-100
71603	Ba	100-200
71598**	Th	0.32

* Milligrams per square centimeter per day

** Al inadvertently omitted; Mg-1Th binary

Table V

OVERALL EFFECT OF ADDITIONS ON MECHANICAL PROPERTIES

A) Mg-3Zn Alloys

Alloy Number	Addition	Avg. Properties %E	Avg. Properties 1,000 psi TYS	Avg. Properties 1,000 psi CYS	Avg. Properties 1,000 psi TS	Avg. Effect %E	Avg. Effect 1,000 psi TYS	Avg. Effect 1,000 psi CYS	Avg. Effect 1,000 psi TS
71567	--	15.3	23.1	13.7	35.0	--	--	--	--
71561	MM	15.4	22.6	13.6	35.3	+0.1	-0.5	-0.1	+0.3
71562	Hg	16.6	23.7	15.1	36.2	+1.3	+0.6	+1.4	+1.2
71563	Tl	14.1	23.7	13.9	35.6	-1.2	+0.6	+0.2	+0.6
71564	Pd	14.1	25.1	17.2	36.2	-1.2	+2.0	+3.5	+1.2
71565	Li	13.9	24.0	16.6	34.4	-1.4	+0.9	+2.9	-0.6
71566	Th	14.2	30.4	21.9	39.1	-1.1	+7.3	+8.2	+4.1
71568	Cr	15.0	24.1	14.8	36.0	-0.3	+1.0	+1.1	+1.0
71569	Cb	15.2	22.7	13.5	35.4	-0.1	-0.4	-0.2	+0.4
71570	Mo	15.4	22.8	13.9	35.8	+0.1	-0.3	+0.2	+0.8
71571	Se	15.0	22.5	13.6	35.2	-0.3	-0.6	-0.1	+0.2
71572	Te	15.0	23.6	14.3	35.9	-0.3	+0.5	+0.6	+0.9
71573	Ba	15.6	25.9	17.3	37.1	+0.3	+2.8	+3.6	+2.1
71574	Ti	15.1	22.3	13.2	34.9	-0.2	-0.8	-0.5	-0.1
71575	V	15.1	23.1	13.8	35.6	-0.2	0.0	+0.1	+0.6
71576	W	15.1	22.8	13.4	35.1	-0.2	-0.3	-0.3	+0.1
71577	Ta	15.0	23.3	13.9	35.7	-0.3	+0.2	+0.2	+0.7

Table V (cont.)

B) Mg-5Al Alloys

Alloy Number	Addition	Avg. Properties %E	Avg. Properties 1,000 psi TYS	Avg. Properties 1,000 psi CYS	Avg. Properties 1,000 psi TS	Avg. Effect %E	Avg. Effect 1,000 psi TYS	Avg. Effect 1,000 psi CYS	Avg. Effect 1,000 psi TS
71587	--	15.6	25.5	17.4	39.4	---	---	---	--
71588	MM	15.4	25.9	18.1	39.3	-0.2	+0.4	+0.7	-0.1
71589	Hg	15.8	24.9	17.9	40.0	+0.2	-0.6	+0.4	+0.6
71590	Li	13.5	27.3	19.1	39.8	-2.1	+1.8	+1.7	+0.4
71591	Se	16.0	24.5	17.6	39.3	+0.4	-1.0	+0.2	-0.1
71592	Te	15.4	25.0	17.7	39.4	-0.2	-0.5	+0.3	0.0
71593	Pd	13.8	26.2	18.5	38.8	-1.8	+0.7	+1.1	-0.6
71594	Cr	14.9	26.0	18.1	39.6	-0.7	+0.5	+0.7	+0.2
71595	Cb	15.8	24.5	17.1	39.0	+0.2	-1.0	-0.3	-0.4
71596	Mo	15.5	25.2	17.4	39.4	-0.1	-0.3	0.0	0.0
71597	Tl	15.4	25.0	17.8	39.9	-0.2	-0.5	+0.4	+0.5
71599	Ti	15.7	25.0	17.4	39.2	+0.1	-0.5	0.0	-0.2
71600	V	15.9	25.2	17.6	39.9	+0.3	-0.3	+0.2	+0.5
71701	W	15.5	24.9	17.1	39.4	-0.1	-0.6	-0.3	0.0
71602	Ta	15.9	24.9	16.8	39.3	+0.3	-0.6	-0.6	-0.1
71603	Ba	12.9	27.2	19.6	39.8	-2.7	+1.7	+2.2	+0.4
71598*	Th	14.4	22.4	17.9	32.8	---	---	---	---

* Al inadvertently omitted; Mg-1Th binary

Table VI

TYPICAL PROPERTIES* - EXTRUSIONS

A) Mg-3Zn Alloys

Alloy No.	Composition	F*** %E	F*** TYS (1,000 psi)	F*** CYS (1,000 psi)	F*** TS (1,000 psi)	F*** NBE**	T5**** %E	T5**** TYS (1,000 psi)	T5**** CYS (1,000 psi)	T5**** TS (1,000 psi)	T5**** NBE**
71567	Mg-3Zn	20	18	10	33	28	17	22	12	35	25
71566	Mg-3Zn-1Th	12	30	20	39	22	14	31	20	40	23
71573	Mg-3Zn-1Ba	18	23	15	37	21	17	25	16	37	17
71564	Mg-3Zn-1Pd	15	23	16	36	20	14	22	15	36	19
71565	Mg-3Zn-1Li	20	19	15	33	28	17	24	17	34	--
71562	Mg-3Zn-1Hg	22	18	11	35	27	19	22	14	36	28
71568	Mg-3Zn-.0Cr	20	19	11	34	28	17	22	13	36	26

B) Mg-5Al Alloys

Alloy No.	Composition	F*** %E	F*** TYS (1,000 psi)	F*** CYS (1,000 psi)	F*** TS (1,000 psi)	F*** NBE**	T5-**** %E	T5-**** TYS (1,000 psi)	T5-**** CYS (1,000 psi)	T5-**** TS (1,000 psi)	T5-**** NBE**
71587	Mg-5Al	17	22	13	38	22	19	21	14	38	18
71603	Mg-5Al-1Ba	16	23	16	39	13	15	23	16	39	14
71590	Mg-5Al-1Li	16	23	15	39	17	15	23	16	39	12
71593	Mg-5Al-1Pd	17	21	14	36	19	18	21	15	37	16

* Properties of alloys not included are equivalent to those of the base alloy.

** Notch bend energy (toughness) in inch-pounds.

*** As-extruded

**** Aged

Table VII

TYPICAL PROPERTIES* - ROLLED STRIP

A) Mg-3Zn Alloys

		H24**				O***			
			1,000 psi				1,000 psi		
Alloy No.	Composition	%E	TYS	CYS	TS	%E	TYS	CYS	TS
71567	Mg-3Zn	13	24	18	33	20	13	6	30
71566	Mg-3Zn-1Th	16	32	24	39	23	22	16	34
71573	Mg-3Zn-1Ba	18	28	21	37	21	18	12	33
71564	Mg-3Zn-1Pd	13	28	20	37	20	19	12	33
71565	Mg-3Zn-1Li	13	24	20	34	23	16	8	31
71562	Mg-3Zn-Hg	14	26	20	37	22	16	9	33
71655	Mg-3Zn-.0Cr	13	26	20	37	22	16	9	32

B) Mg-5Al Alloys

		H24**				O***			
			1,000 psi				1,000 psi		
Alloy No.	Composition	%E	TYS	CYS	TS	%E	TYS	CYS	TS
71587	Mg-5Al	18	28	24	42	21	23	15	38
71603	Mg-5Al-1Ba	9	30	24	39	15	25	17	38
71590	Mg-5Al-1Li	9	29	26	41	22	22	15	37
71593	Mg-5Al-1Pd	16	29	23	41	18	22	15	37

* Properties of alloys not included are equivalent to those of the base alloy

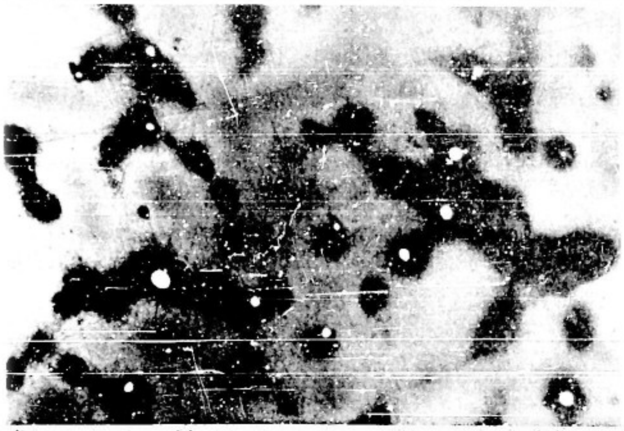
** Cold rolled plus hard anneal

*** Cold rolled plus soft anneal

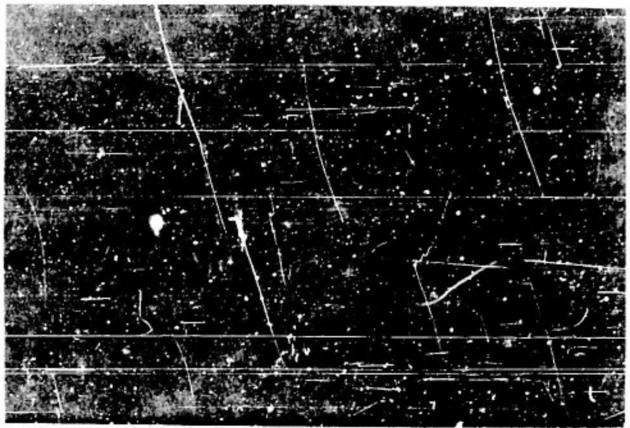

0 1 2 4 5
CLEANLINESS RATING

FIGURE 2

CAST MICROSTRUCTURE OF THE Mg-3Zn ALLOYS



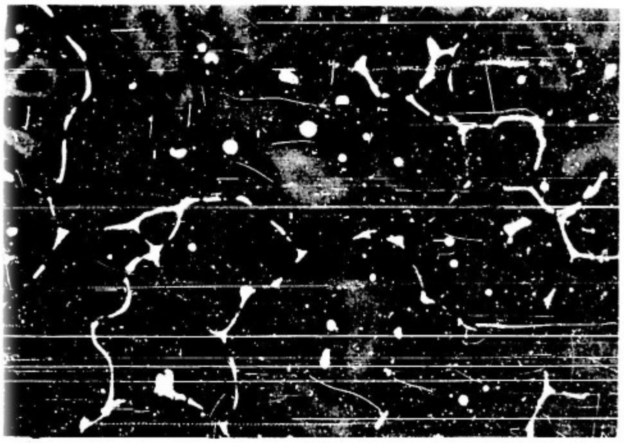
Neg. 31415 100X
Alloy No. 71567
Etchant = Phospho Picral



Neg. 31387 100X
Alloy No. 71567
Etchant = Phospho Picral

a.) Mg-3Zn Base

AC SHT



Neg. 31382 100X
Alloy No. 71564
Etchant = Phospho Picral

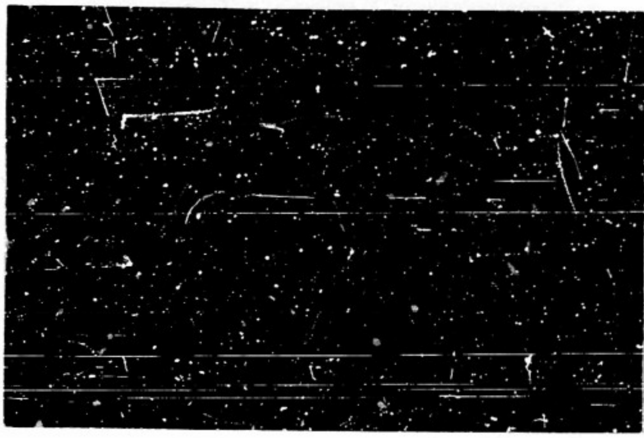
Neg. 31383 100X
Alloy No. 71564
Etchant = Phospho Picral

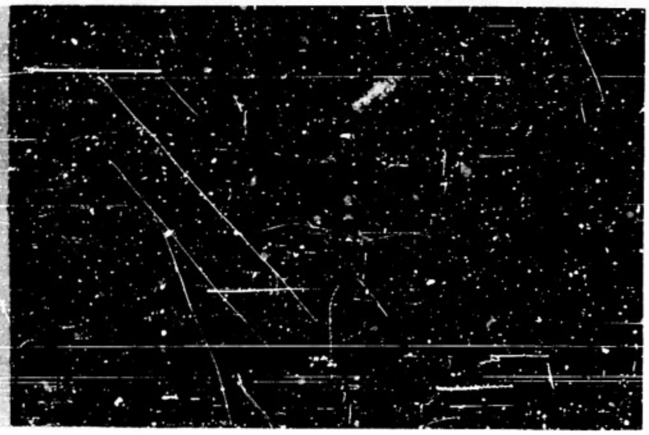
b.) Mg-3Zn - 1 Pd

SHT

FIGURE 2 (Cont'd)

CAST MICROSTRUCTURE OF THE Mg-3Zn ALLOYS





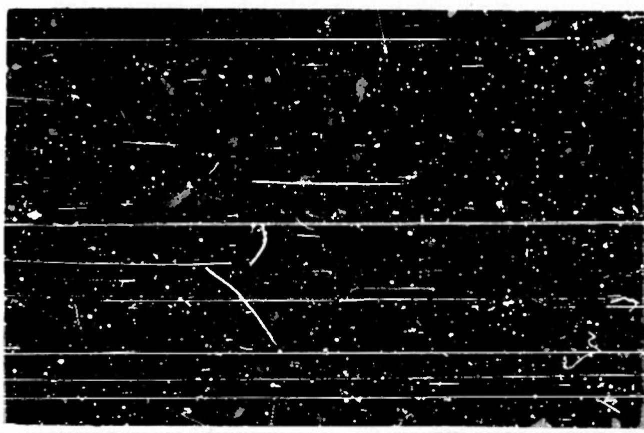
Neg. 31388 100X
Alloy No. 71566
Etchant - Phospho Picral

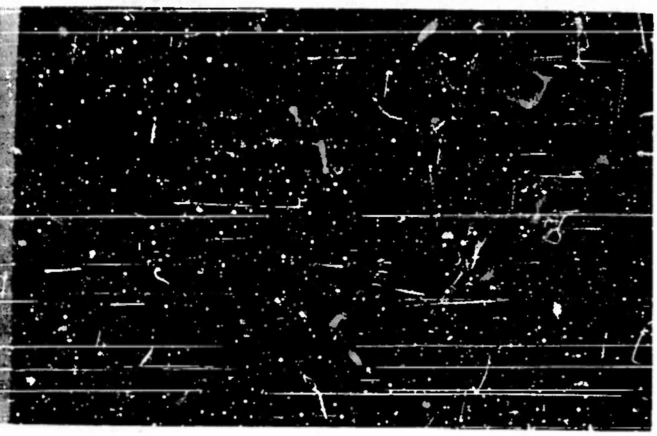
Neg. 31389 100X
Alloy No. 71566
Etchant - Phospho Picral

c.) Mg-3Zn - 1Th

AC

SHT





Neg. 31384 100X
Alloy No. 71573
Etchant: Phospho Picral

Neg. 31414 100X
Alloy No. 71573
Etchant: Phospho Picral

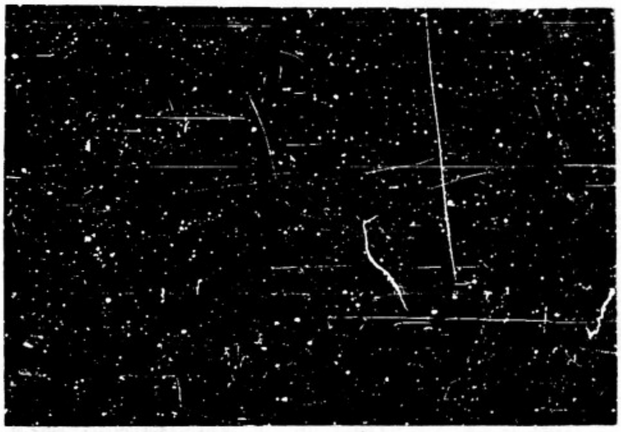
d.) Mg-3Zn - 1Ba

AC

SHT

FIGURE 3

CAST MICROSTRUCTURE OF Mg-5Al ALLOYS

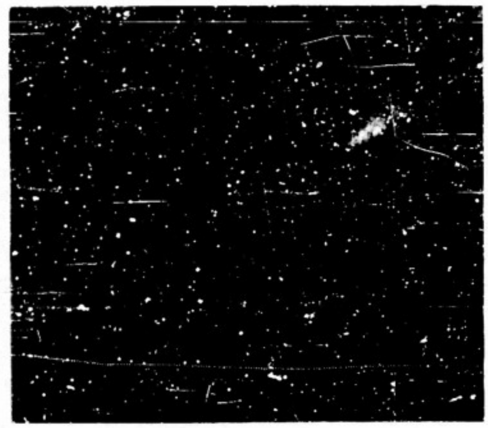


Neg. 31390 100X

Alloy No. 71587

Etchant: Phospho Picral

AC



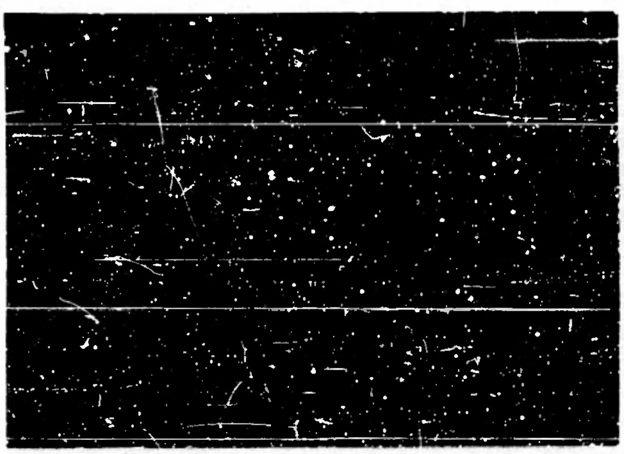
Neg. 31391 100X

Alloy No. 71587

Etchant: Phospho Picral

SHT

a.) Mg-5Al Base



Neg. 31396 100X

Alloy No. 71593

Etchant: Phospho Picral

AC

Neg. 31397 100X

Alloy No. 71593

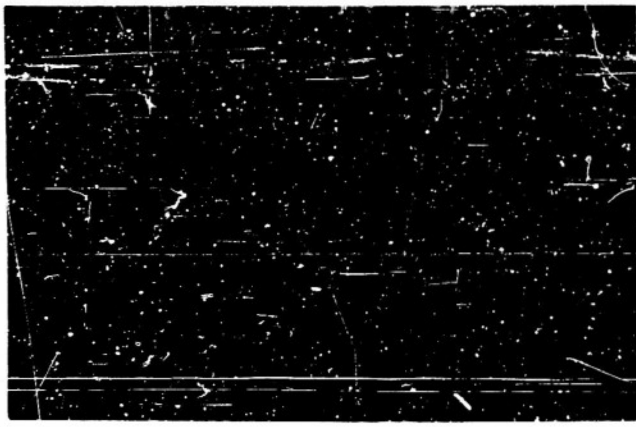
Etchant: Phospho Picral

SHT

b.) Mg-5Al - 1Pd

FIGURE 3 (Cont'd)

CAST MICROSTRUCTURE OF Mg-5Al ALLOYS



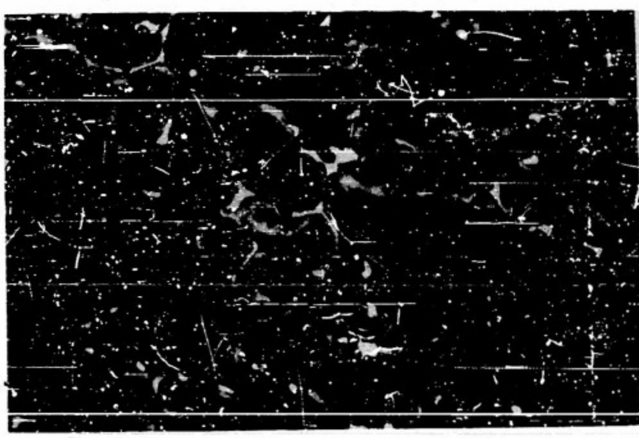
Neg. 31398 100X
Alloy No. 71598
Etchant: Phospho Picral

AC

Neg. 31399 100X
Alloy No. 71598
Etchant: Phospho Picral

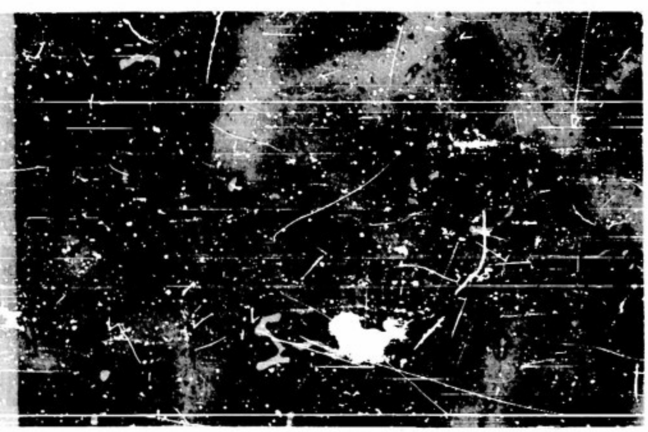
SHT

c.) Mg-1Th (no Al)



Neg. 31416 100X
Alloy No. 71603
Etchant: Phospho Picral

AC



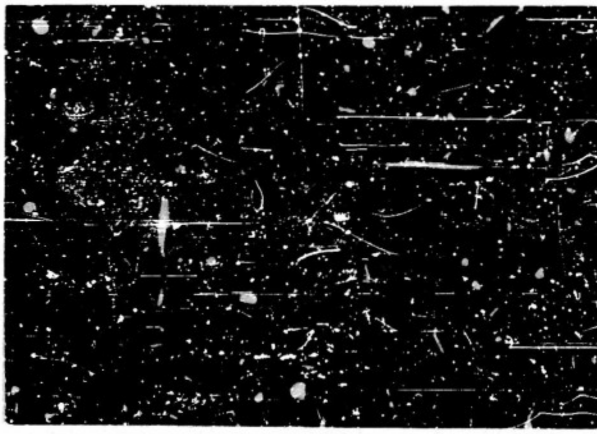
Neg. 31393 100X
Alloy No. 71603
Etchant: Phospho Picral

SHT

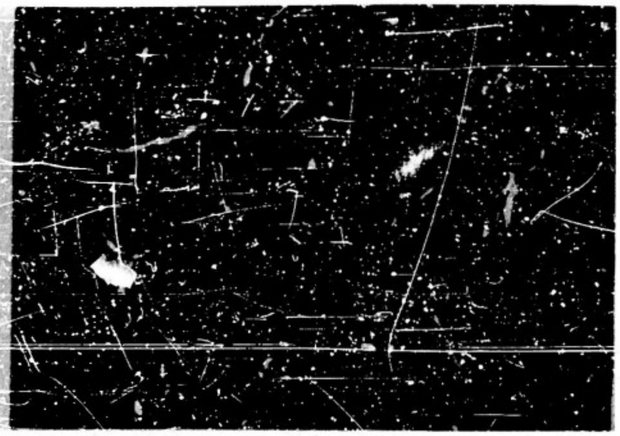
d.) Mg-5Al - 1Ba

FIGURE 3 (Cont'd)

CAST MICROSTRUCTURE OF MG-5Al ALLOYS



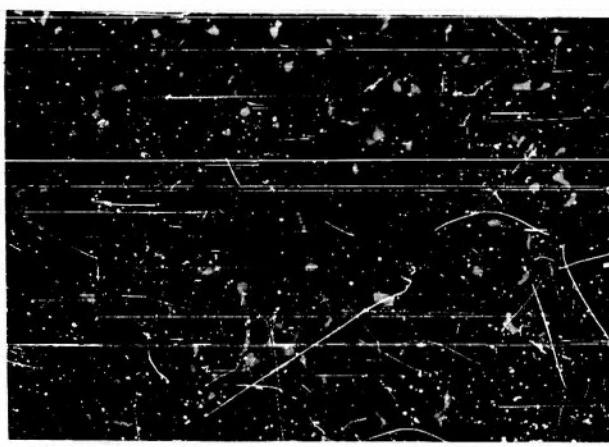
Neg. 31400 100X
Alloy No. 71538
Etchant: Phospho Picral



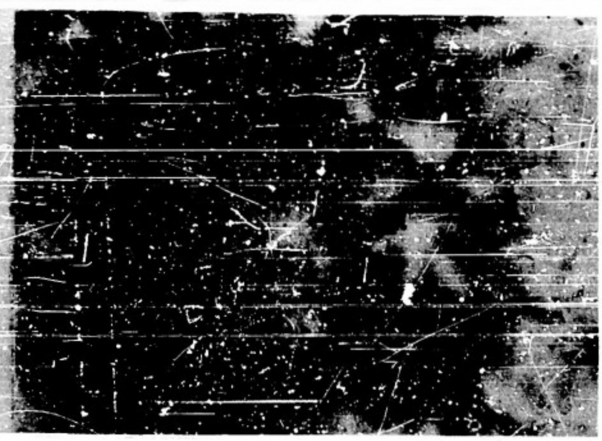
Neg. 31401 100X
Alloy No. 71538
Etchant: Phospho Picral

e.) Mg-5Al - 1MM

AC SHT



Neg. 31394 100X
Alloy No. 71590
Etchant: Phospho Picral



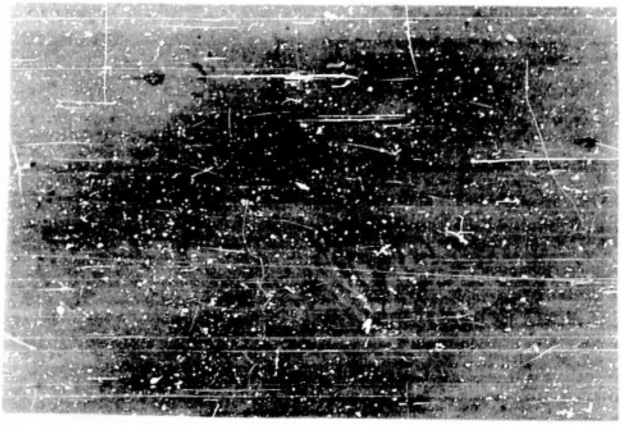
Neg. 33657 100X
Alloy No. 71590
Etchant: Phospho Picral

f.) Mg-5Al - 1Li

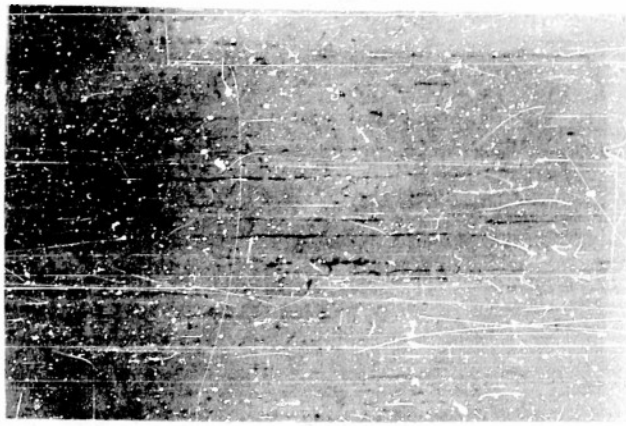
AC SHT

FIGURE 4

Microstructure of Extruded Mg-3Zn Alloys

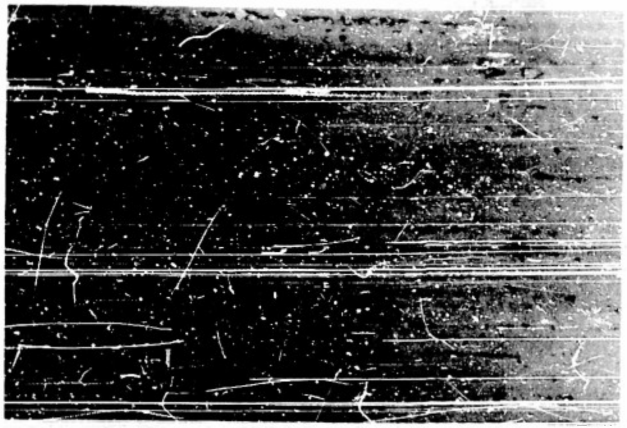


Neg. No. 33658 250x
Etchant: Phospho Picral
Alloy No. 71567
a.) Mg-3Zn



Neg. No. 33659 250x
Etchant: Phospho Picral
Alloy No. 71566
b.) Mg-3Zn-1Th

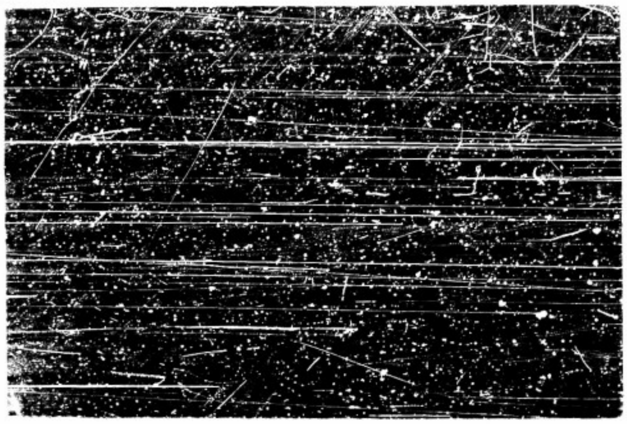
Neg. No. 33660 250x
Etchant: Phospho Picral
Alloy No. 71564
c.) Mg-3Zn-1Pd



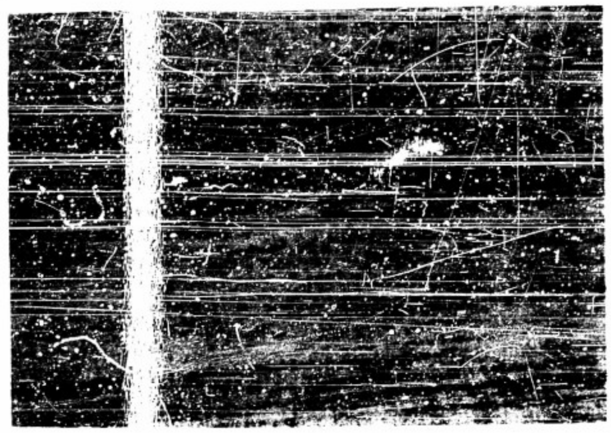
Neg. No. 33661 250x
Etchant: Phospho Picral
Alloy No. 71573
d.) Mg-3Zn-1Ba

FIGURE 5

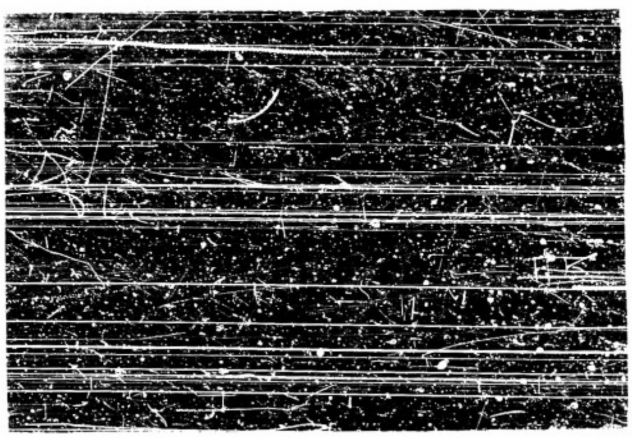
Microstructure of Extruded Mg-5Al Alloys



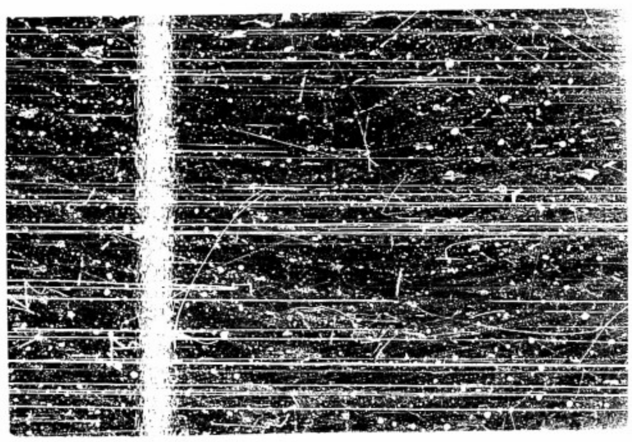
Neg. No. 33662 250x
Etchant: Phospho Picral
Alloy No. 71587
a.) Mg-5Al



Neg. No. 33663 250x
Etchant: Phospho Picral
Alloy No. 71588
b.) Mg-5Al-1MM



Neg. No. 33665 250x
Etchant: Phospho Picral
Alloy No. 31593
c.) Mg-5Al-1Pd



Neg. No. 33666 250x
Etchant: Phospho Picral
Alloy No. 71603
d.) Mg-5Al-1Ba